Assessing the impact of distant sources of ozone on the Houston area using the RAQMS global chemical model and TES satellite observations: a test case for August 23rd 2006

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TCEQ High Priority SIP-Relevant Science Questions

- G: How do emissions from local and distant sources interact to determine the air quality in Texas? What meteorological and chemical conditions exist when elevated background ozone and aerosol from distant regions affect Texas? How high are background concentrations of ozone and aerosol, and how do they vary spatially and temporally?
- H: Which areas within Texas adversely affect the air quality of non-attainment areas within Texas? Which areas outside of Texas adversely affect the air quality of non-attainment areas within Texas?

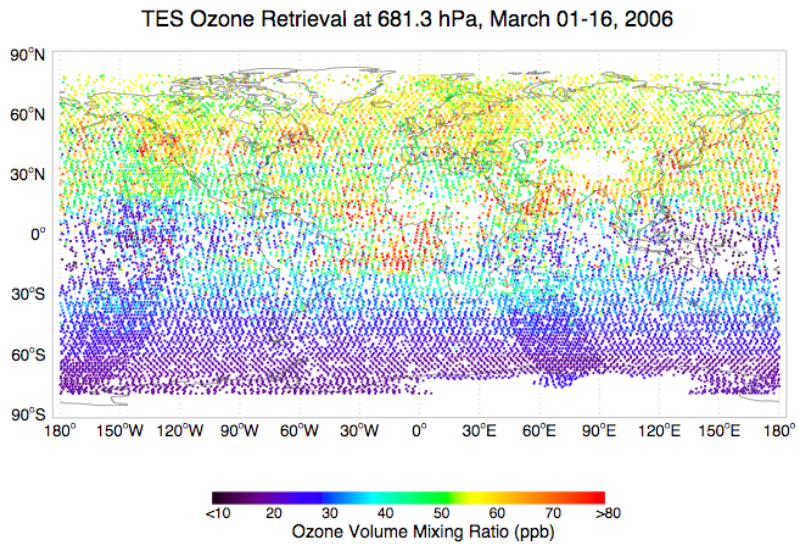
Synthesis of satellite observations, *in-situ* measurements, and chemistry and transport models

- Observations of ozone and carbon monoxide profiles in the free troposphere from TES can provide critical information for studying boundary layer exchange.
- Ground *in-situ* observations such as AIRNow are the standard for boundary layer measurements of ozone and its precursors
- Chemistry and transport models such as the real-time air quality modeling system (RAQMS) are the critical link between these two observations
- The integration of these assets can provide valuable input into the science objectives for TexAQS.

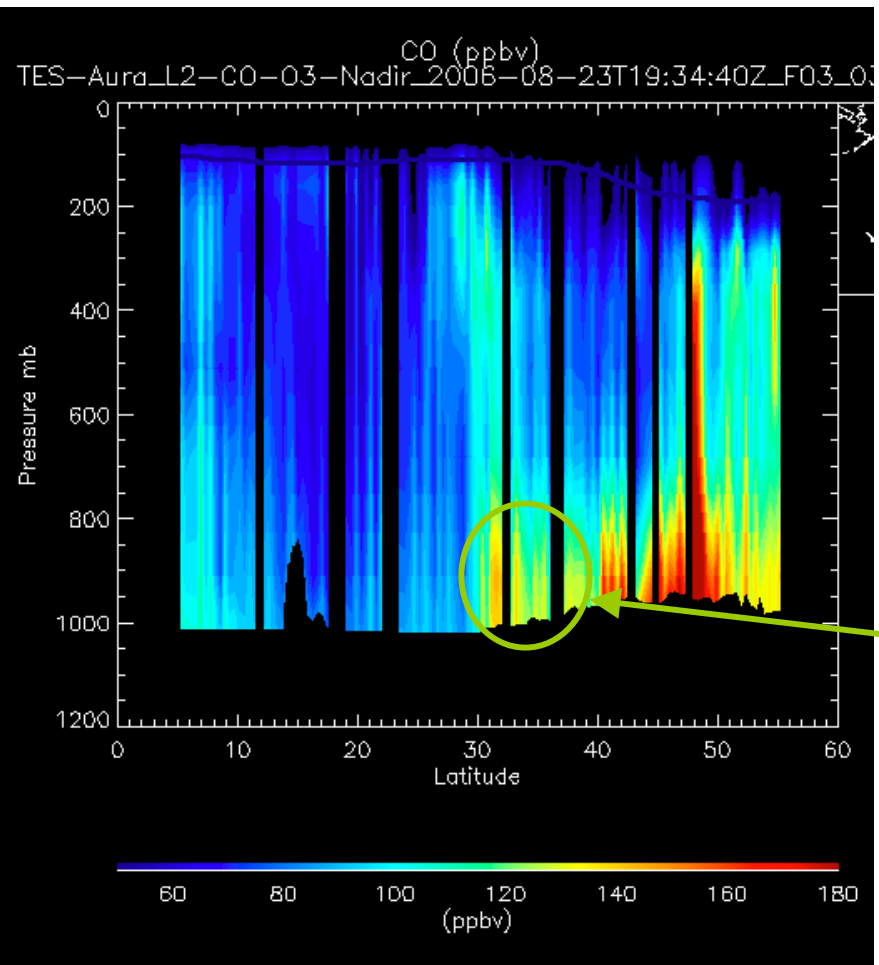
TES is a Fourier transform spectrometer specifically designed to measure tropospheric ozone and its precursors

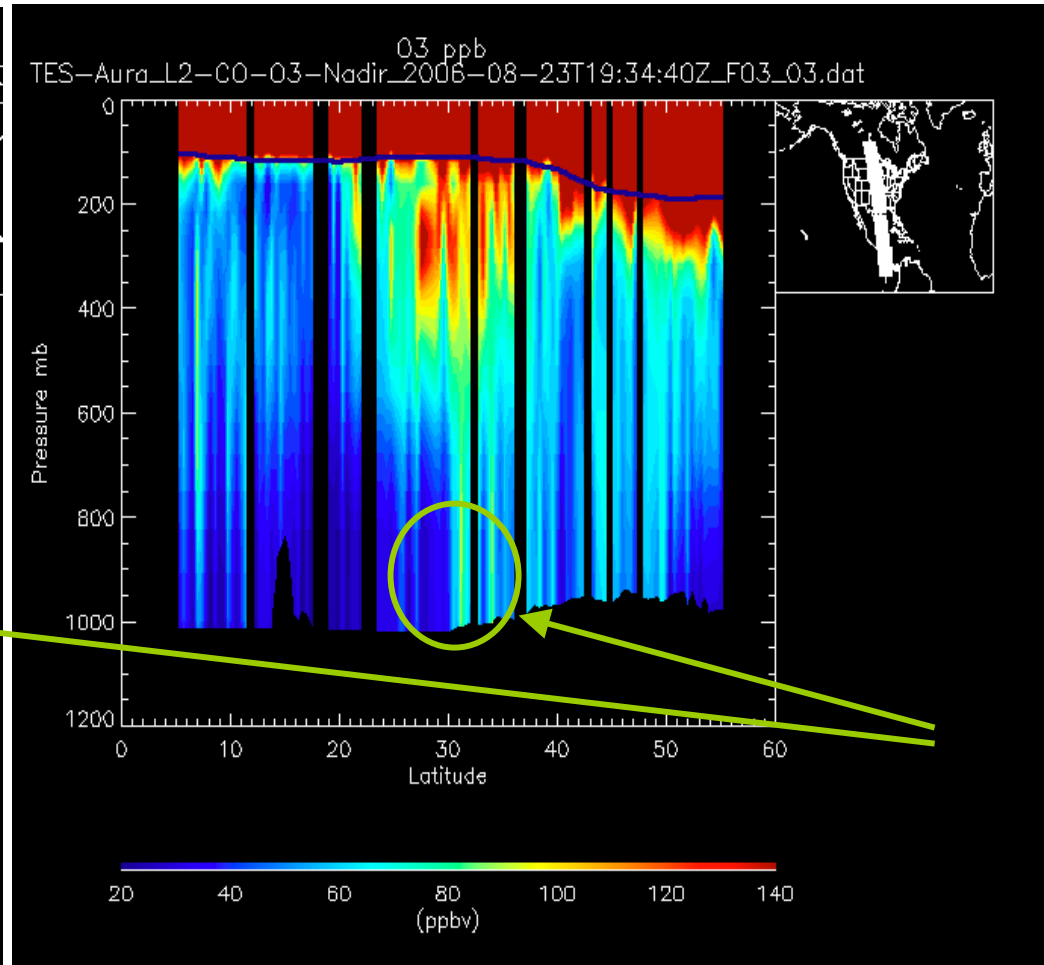
- .1 cm^{-1} spectral resolution (apodized)
- 650 to 3050 cm^{-1} (3.2 to 15.4 microns)
- 0.5 x 5 km (nadir) spatial resolution
- 3 observation modes
  - Global survey (72 obs/orbit, 16 orb/day, ~1.3 deg lat)
  - Step and stare (~.4 deg lat)
  - Transect (near-continuous)
- Estimates vertical profiles from the surface to .01 mb of temperature, H_2O,ozone, carbon monoxide, HNO_3 as well as emissivity, surface temperature, and effective cloud parameters
- Estimates made both for day and night

TES "global survey" mode

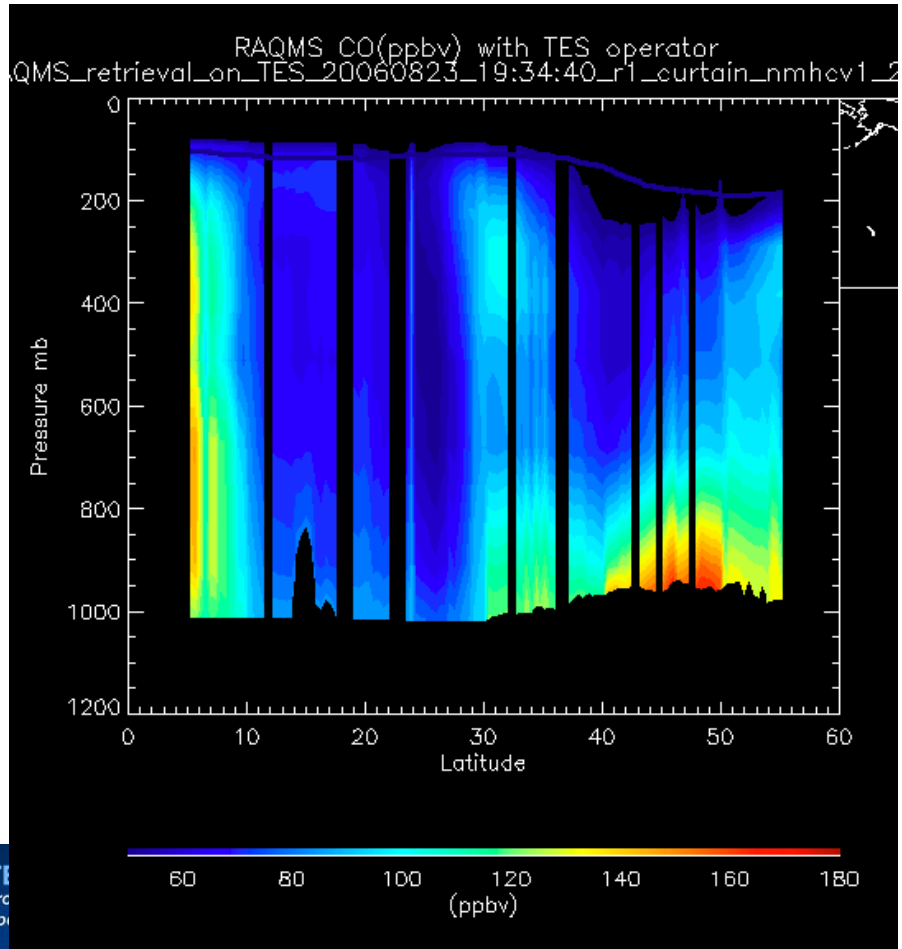


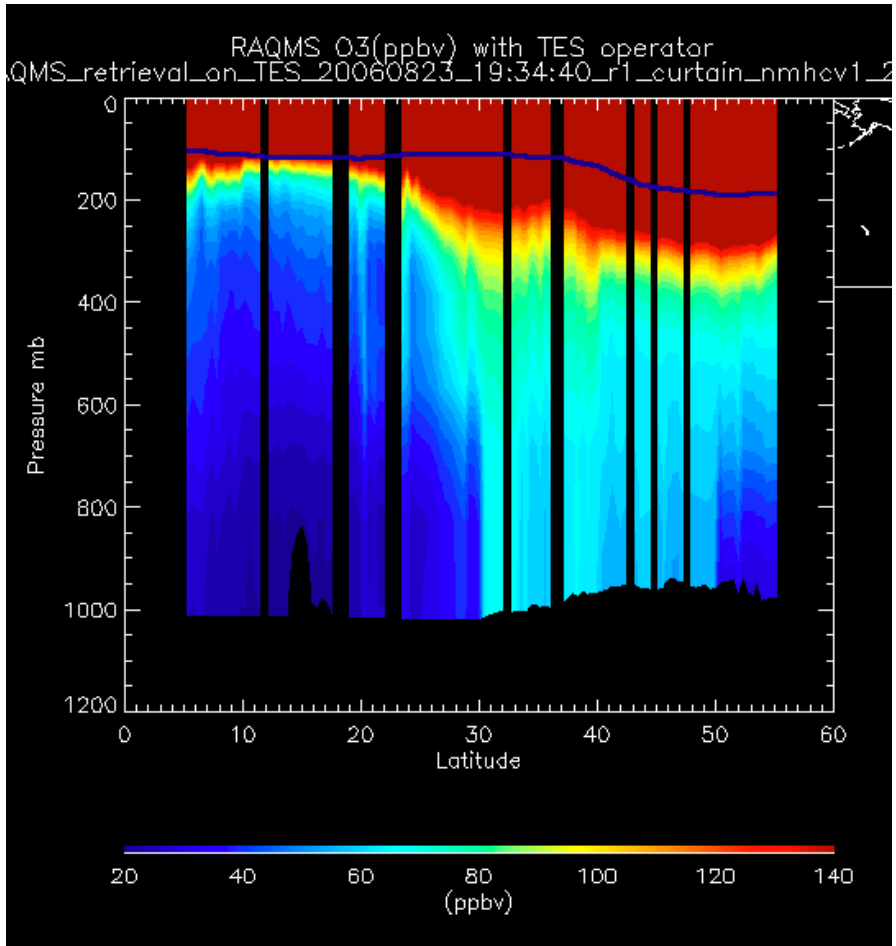
Elevated CO and ozone over Houston region observed from TES “special observations” Aug 23rd, 2006



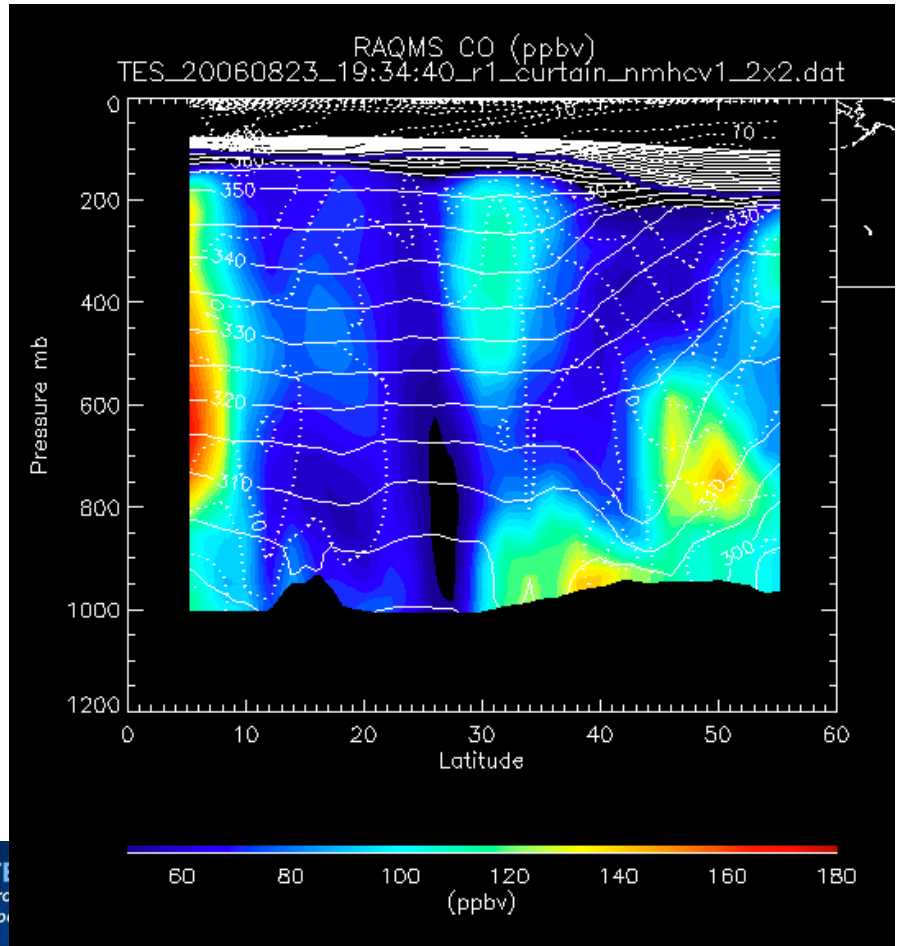


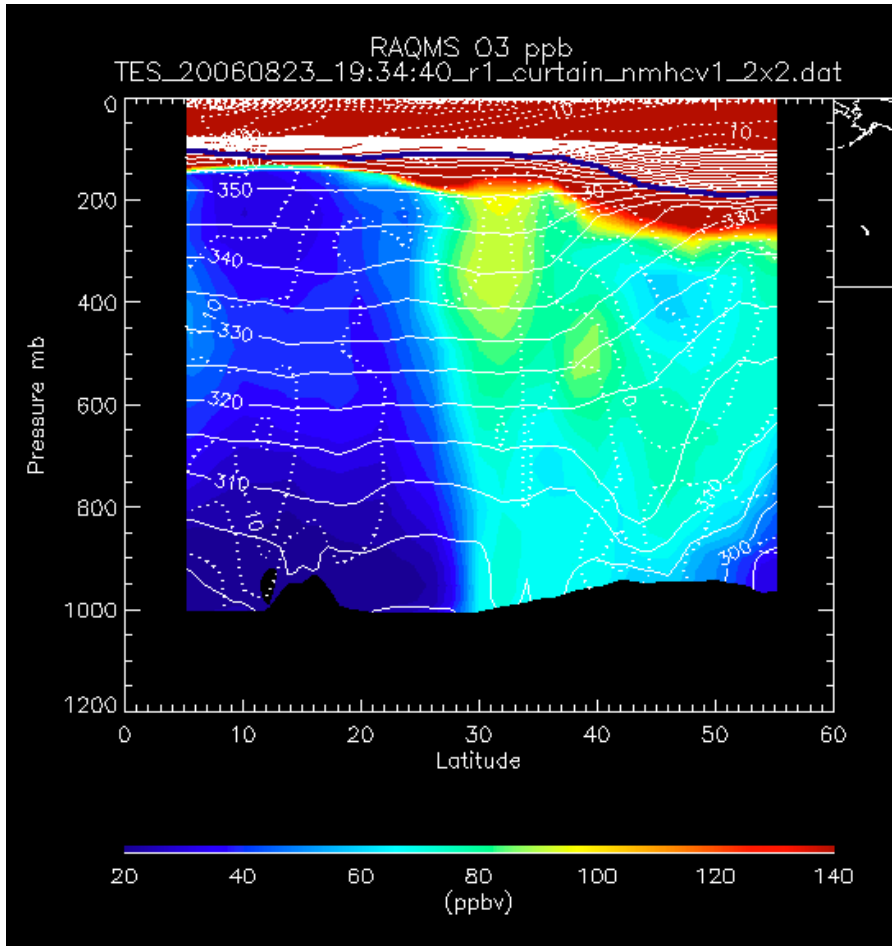
RAQMS with the TES *observation operator*



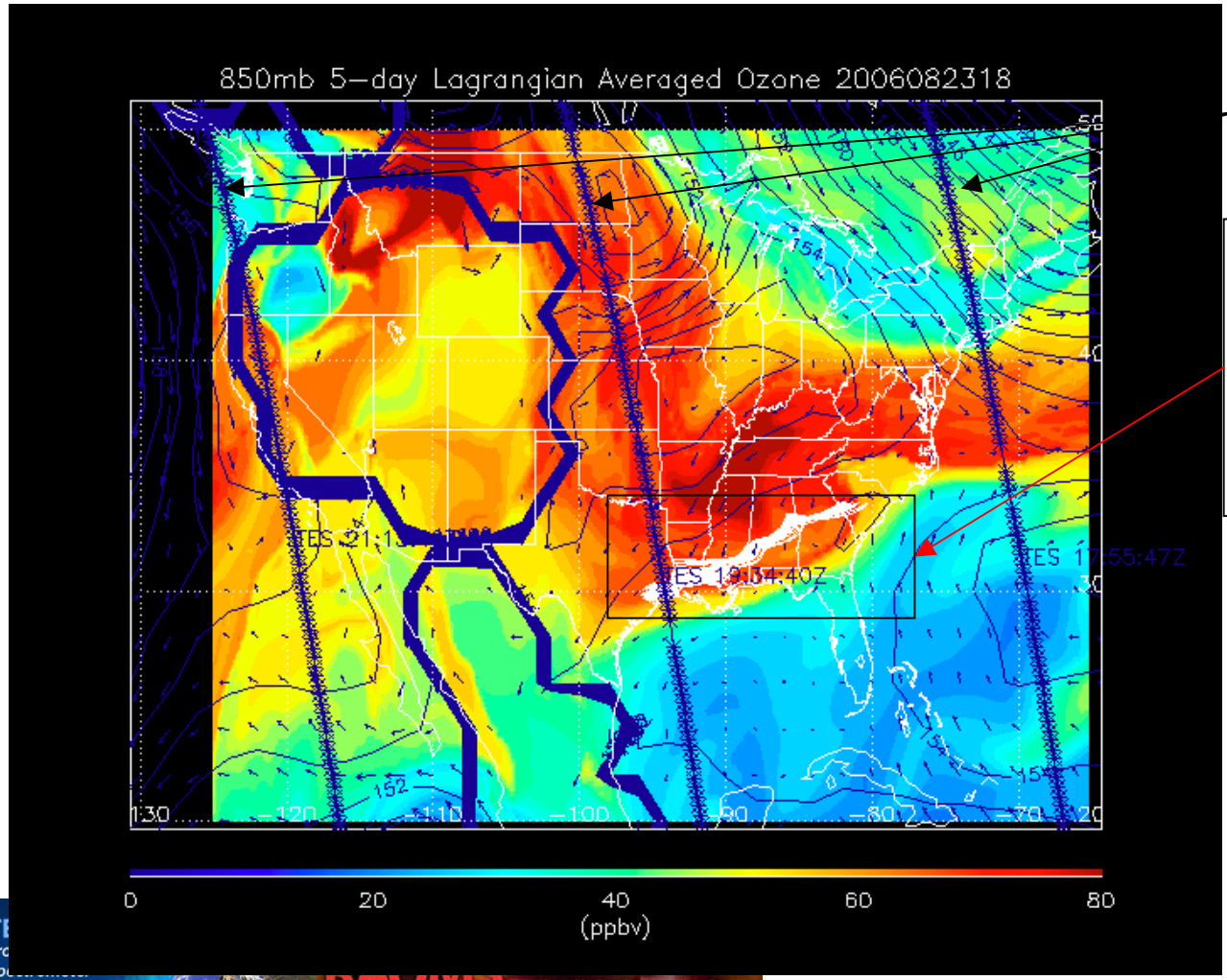


RAQMS CO and ozone model fields





What is the origin of the ozone and CO enhancement?

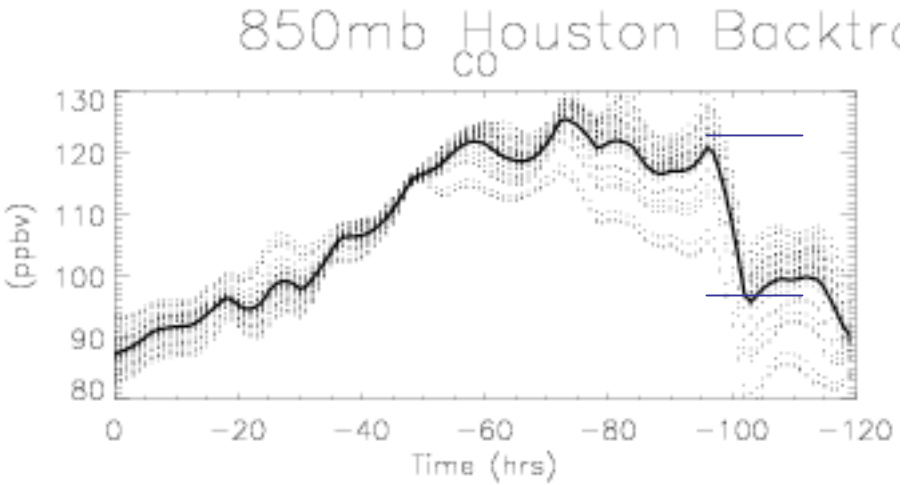


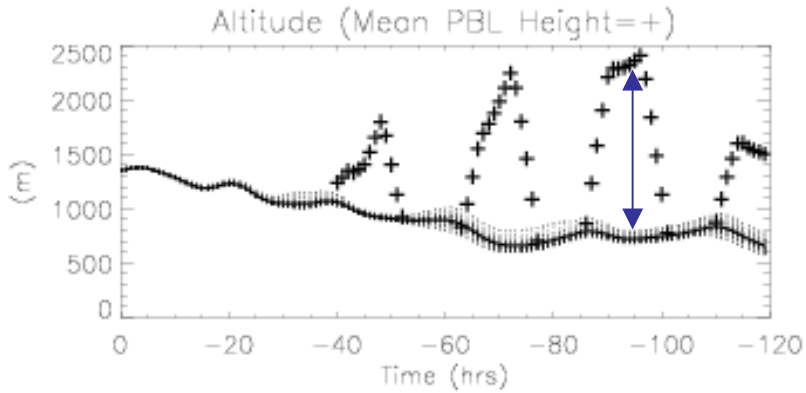
White lines represent 5-day back-trajectories emanating from Houston AIRNow Metropolitan statistical area (MSA) sites

Each point represents ozone averaged over a 5-day back-trajectory

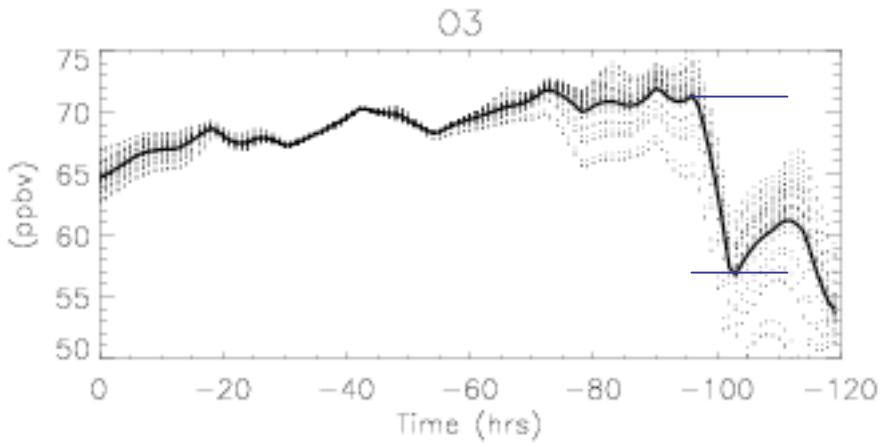
Moderate values (60-70ppb) over Houston, but high values over Tennessee, Kentucky, Alabama, and Arkansas (~80 ppb)

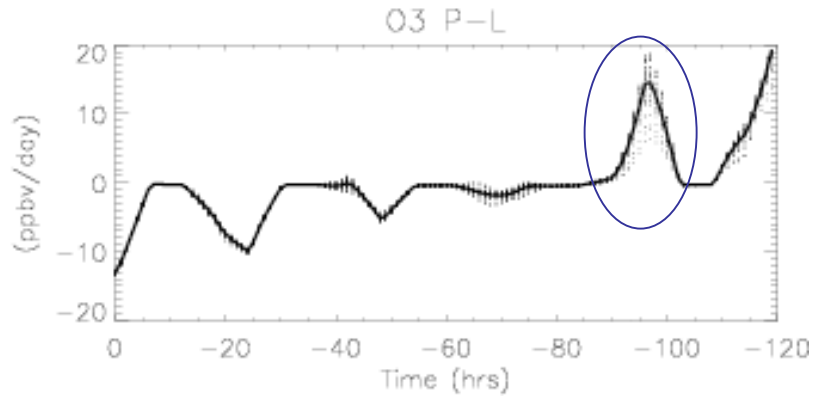
Process history of ozone and CO





Ozone production in the boundary layer about 4 days prior to arrival in Houston





Conclusions

- TES retrievals of CO and ozone vertical profiles in conjunction with the RAQMS global model provide a means of investigating the impact of distant sources on the background concentrations over Texas.
- Enhancement observed from TES east of the Houston area in both CO and ozone, slightly higher than RAQMS fields.
- Model analysis suggests anthropogenic production of ozone from surface emissions at -90 hrs.
- Ozone at 850 mb on Aug 23rd, 2006 is above the boundary layer and therefore will have minimal impact on Houston air quality.
- Validation of TES estimates with respect to IONS ozone sonde measurements will be performed.
- Additional information for RAQMS (http://rossby.larc.nasa.gov/RAQMS/) and TES (http://tes.jpl.nasa.gov/TexAQS_2006/main_SS_TEXAQS_2006.html)

Back-up slides

TES sensitivity metric: the averaging kernel